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Research Article

Induction of mutation in commercial varieties of gladiolus using physical mutagen CO-60 gamma rays

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Abstract

Influence of gamma radiations from Co-60 was studied in three varieties of gladiolus (*Gladiolus hybrida* L.) namely, American Beauty, Nova Lux and Eurovision irradiated with 1, 2, 3, 4, 5, 6 and 7 kR doses and planted at Floricultural Farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari. Percentage of sprouting and survival was affected significantly at 1 kR to 4 kR. LD₅₀ was found to be beyond 7 kR dose for both sprouting and survival. Doses of 4 kR and above proved to be detrimental for various vegetative and floral traits. Plants treated with 6 kR and 7 kR did not produced flower spikes in cv. Nova Lux and Eurovision whereas cv. American Beauty had produced few flower spikes. When corms were treated with higher doses, plant height, leaf number and leaf size were reduced significantly and leaves become narrow and leathery. Colour variations in florets and whole spike were also increased with increase in dose rate along with increase or decrease in number of floral organs. Radiation treatments at higher doses caused delayed in spike initiation with decrease in spike length, number and size of florets, vase life and yield per plot while lower doses responded positively. Three desirable mutants with light colours were isolated from all three varieties in 5 kR whereas one mutant have bifurcated spike at 6 kR from cv. American Beauty and they are isolated for further study in vM₂ generation.

Keywords: gamma radiations, *Gladiolus hybrida* L., sprouting and survival

Introduction

Mutations are induced in different crops to create variability for further improvement. In vegetatively propagated plants, mutation breeding offers great potentialities as the mutated part can be conveniently perpetuated by vegetative means resulting in the development of new forms. Gladiolus is highly heterozygous in its genetic constitution which makes it promising test material for inducing physical mutagenesis. The effects of gamma rays on gladiolus have been studied by several workers but very few varieties have been developed through gamma radiations. Hence, in the present investigation, emphasis was laid on finding out variations caused by gamma radiations in morphological characters including colour

variations. An attempt was made to develop a variety by fixing the induced variation in succeeding generations.

Materials and Methods

The present experiment was carried out at the Floriculture farm, Division of Floriculture and Landscaping, Department of Horticulture, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat, during winter season. The dormant corms (3.5 to 4.5 cm diameter) of three commercial varieties of gladiolus viz., American Beauty, Nova Lux and Eurovision were subjected to Co-60 gamma radiations at Bhabha Atomic Research

Station, Trombay. The corms were treated with 7 doses of gamma radiations from 1 kR to 7 kR along with control (without treatment). The corms were planted in the field within 24 hours of treatment in Randomized Block Design with Factorial Concept (Panse and Sukhatme, (11)) putting 16 corms per treatment per replication. Data were recorded in vM_1 generation on different qualitative as well as quantitative parameters.

Results and Discussion

Analysis of variance indicated highly significant difference between gamma rays treatments except number of florets per spike and floret size which were significant at 5 per cent only. The mean sum of square due to varieties and treatments were significant for all the characters except weight of cormels per plant which was found non significant in case of varieties.

Mean effect of radiation doses and varieties is presented in Table 1 and 2, respectively. Sprouting percentage and percentage of survival decreased significantly from 2 kR treatment compared to control (100%) and 1 kR (100%) treatment in all varieties. Significantly minimum survival and sprouting of plants was noted in 7 kR dose. Though the sprouting was more, percentage of survival was found less after one month. This revealed that higher doses of gamma rays are detrimental for irradiation of gladiolus corms. Significantly maximum sprouting (93.28%) and survival (91.84%) was noted in cv. Nova Lux. These results are in parallel line of work reported by Misra (5) who stated that higher doses of gamma radiations adversely affect both sprouting and survival in cv. Oscar. LD_{50} for sprouting and survival was found beyond 7 kR treatment. Similar results were reported by Raghava *et al.* (13) as they found LD_{50} between 10 kR to 15 kR for cvs. Wild Rose, Mansoer and Little Giant. Doses of 5 kR to 7 kR delayed sprouting significantly in comparison to lower exposures. Treatment 2 kR induced earliness in sprouting by taking 12.30 days which was *at par* with 1 kR treatment (12.74 days). Number of sprouts found significant due to treatments and maximum sprouts per corm were noted under 2 kR treatment (2.71) followed by 1 kR and 3 kR doses. Cv. American Beauty had produced maximum number of sprouts (3.25) then cvs. Nova Lux and Eurovision. Similar results were found by Dhaduk (2) in cv. Melody at 1 kR dose. The lower levels of mutagens are themselves not responsible for stimulating sprouting but the substances such as enzymes that are set free by irradiation whereas lower doses cause stimulations as the enzymes play pivotal role in plant metabolism. It is striking to note that 2 kR

treatment produced more heightened plant (106.57 cm) having more number of leaves (18.52) with maximum length and breadth of leaves (72.96 cm and 3.03 cm, respectively) which was followed by 1 kR and 3 kR doses. These vegetative characters started to decline with progressive increase in doses. Plants produced by corms treated with 7 kR were shortest having minimum number of leaves with less length and breadth. These results are in agreement to Misra (6) and Misra and Bajpai (7). Among all varieties, cv. Nova Lux was significantly superior which produced taller plants of 93.04 cm with maximum length as well as breadth of leaves (66.87 cm and 2.59 cm, respectively) then other varieties while significantly maximum number of leaves (21.35) was recorded in cv. American Beauty. Such results have also been reported by Misra (6) and Misra and Mahesh (8) which may be due to activation of physiological substances at lower doses that are present in corm while higher doses retard cell division by arresting mitotic cell division. Srivastava *et al.* (14) reported that higher radiation doses might have harmful effects on auxins and other growth substances influencing the chromosomes and the plant tissue. Different types of vegetative abnormalities were noted in different treatments in all varieties. Two plantlets from a single corm sheath, leaf doubling, bifurcation and yellowing of newly born leaves were observed at 3 kR to 5 kR treatments. Leathery and wavy leaves with stunted growth of leaves which thickened at later stage and bending towards soil were observed at 6 kR and 7 kR treatments in vM_1 generation. Lack of chlorophyll on half portion of leaf (vertical white strip on half side of leaf) was noted at 4 kR treatments in different varieties. Similar findings were reported by Lim (4) in different ornamental crops.

Observations on floral characteristics were recorded on control to 5 kR treatments as the plants did not produce flower spikes and remained blind at 6 kR and 7 kR treatments. The treatment of 2 kR gamma rays dose induced fast initiation of spike as it required only 55.70 days and 65.07 days to open first floret on spike. Moreover, 1 kR and 3 kR treatments also induced earliness as compared to control and other doses. Although spike initiation and opening of first floret was delayed with increase in doses which showed that maximum days taken by corms that treated with the dose of 5 kR gamma rays. Similar type of stimulatory effect was observed earlier by Misra and Bajpai (7) with 2 kR and 3 kR dose in nine cultivars and by Dhaduk (2) in four varieties of gladiolus. Raghava *et al.* (13) and Negi *et al.* (10) were noted that the flowering was delayed significantly at 5 kR treatments in gladiolus. 6 kR and

Table 1. Mean effect of gamma radiations on different morphological characters of commercial varieties of gladiolus in vM₁ generation

Treatments	Sprouting percentage	Survival percentage	Days taken for sprouting	No. of sprouts / corm	Plant height (cm)	No. of leaves / plant	Length of leaves (cm)	Breadth of leaves (cm)	No. of days to spike initiation	No. of days to open 1 st floret	No. of florets / spike
Gamma Rays											
T ₀ -(Control)	100.00	100.00	16.06	2.12	98.78	16.50	71.44	2.83	56.52	67.29	11.81
T ₁ -1 kR	100.00	100.00	12.74	2.27	102.81	17.38	72.18	2.87	55.76	65.07	12.48
T ₂ -2 kR	98.61	97.92	12.30	2.71	106.57	18.52	72.96	3.03	55.70	65.32	12.71
T ₃ -3 kR	94.44	92.36	13.92	2.41	99.68	16.03	68.61	2.71	56.37	66.08	12.21
T ₄ -4 kR	89.64	88.28	15.36	2.24	87.89	13.94	62.11	2.49	58.37	68.90	11.20
T ₅ -5 kR	84.14	81.39	16.82	2.13	75.97	12.26	51.94	2.02	60.58	70.91	9.73
T ₆ -6 kR	79.31	78.46	17.52	1.84	65.58	10.53	47.90	1.80	73.53*	82.05*	6.04*
T ₇ -7 kR	75.81	74.84	18.74	1.56	54.72	9.79	42.17	1.57	79.87*	88.77*	2.48*
C.D. at 5%	3.58	2.79	0.49	0.13	8.69	0.89	1.14	0.13	0.99	0.57	0.41
Cultivars											
American Beauty	91.74	90.70	15.20	3.25	79.06	21.35	52.94	2.06	58.33	68.76	10.03
Nova Lux	93.28	91.84	16.11	1.48	93.04	9.98	66.87	2.59	67.04	76.22	12.85
Eurovision	85.71	84.93	14.99	1.77	87.40	11.78	63.68	2.67	46.28	61.40	12.19
C.D. at 5%	NS	1.71	NS	0.08	1.03	0.55	0.86	NS	0.64	0.64	0.39

*Not included in statistical analysis

Table 2. Mean effect of gamma radiations on different morphological characters of commercial varieties of gladiolus in vM₁ generation

Treatments	Floret diameter (cm)	Length of spike (cm)	Vase life of cut spike (days)	No. of spike / pslant	Yield of spike / plot	Pollen fertility (%)	No. of corms	No. of cormels	Weight of corm (g)	Weight of cormels (g)	Size of corm (cm)
Gamma Rays											
T ₀ -(Control)	8.53	66.53	8.63	2.09	23.38	88.84	2.23	23.30	55.40	5.93	4.65
T ₁ -1 kR	9.24	70.94	9.20	2.20	25.56	86.60	2.61	26.50	61.59	6.89	4.88
T ₂ -2 kR	9.91	73.95	9.46	2.47	29.44	84.00	3.12	30.32	65.23	7.78	5.35
T ₃ -3 kR	9.74	71.16	9.30	2.44	28.39	78.12	2.50	29.71	61.00	6.60	5.26
T ₄ -4 kR	9.09	66.92	8.54	2.22	21.74	71.22	2.09	22.57	54.96	5.46	4.90
T ₅ -5 kR	8.31	60.17	7.76	2.02	16.99	63.93	1.77	20.13	47.76	4.76	4.49
T ₆ -6 kR	5.26*	38.29*	4.88*	1.40*	9.98*	37.22	1.57	16.60	45.08	4.31	3.93
T ₇ -7 kR	1.81*	33.31*	1.84*	1.02*	3.72*	18.13	1.38	12.11	39.03	3.71	3.62
C.D. at 5%	0.23	3.33	0.91	1.24	1.34	3.34	0.18	1.09	3.03	0.34	0.23
Cultivars											
American Beauty	8.94	65.80	8.33	3.73	39.87	85.98	3.21	18.46	80.63	5.11	3.85
Nova Lux	9.57	72.34	10.11	1.60	16.50	70.68	1.75	21.78	53.88	5.73	6.27
Eurovision	8.90	66.70	8.03	1.44	16.38	52.38	1.52	27.72	26.75	6.20	3.79
C.D. at 5%	0.15	0.17	0.62	1.61	0.82	0.23	0.09	0.68	1.85	NS	0.14

*Not included in statistical analysis

7 kR treatments were not included in statistical analysis as they produced few spikes in cv. American Beauty and no spikes in remaining cultivars. From the data, it is revealed that cv. Eurovision is early flowering, cv. American Beauty is mid flowering and cv. Nova Lux is late flowering varieties. Treatment of 2 kR had produced maximum number of florets per spike (12.71) and maximum floret diameter (9.91 cm) which was followed by 1 kR and 3 kR treatments as compared to control and higher doses whereas minimum values were noted under 5 kR treatment. The higher doses of radiations reduced number and diameter of florets and affected adversely which may be because of auxin destruction, irregular auxin synthesis, failure of assimilation, mechanisms or inhibition of mitotic and chromosomal changes or damage with association of secondary physiological damage which support present findings (Dobanda (3)). Among all varieties, cv. Nova Lux produced maximum number of florets (12.85) and maximum diameter of florets (9.57 cm) while performance of other two cultivars was very poor. The data on final length of spike and vase life of spike revealed significant differences due to varieties and treatments. The corms treated with 2 kR produced longest spike of 73.95 cm with maximum vase life of 9.46 days. The lower doses of 1 kR to 3 kR had produced more spike length than control but started to decrease as the dose increased and shortest spike with minimum life of spike in vase was noted under treatment of 5 kR. Cv. Nova Lux had produced longest spike (74.34 cm) with maximum life of 10.11 days in vase whereas very less difference was noted among cvs. American Beauty and Eurovision. Similar results were noted by Srivastava *et al.* (14) and Dhaduk (2) in various cultivars of gladiolus. The number of spikes per plant and yield of spikes per plot was significantly maximum in corms that treated with lower doses of gamma radiations *i.e.* 1 kR to 3 kR and maximum number of spikes per plant (2.47) as well as highest yield per plot (29.44) was noted under 2 kR treatment. Among the three varieties, cv. American Beauty had produced maximum number of spikes per plant (3.73) and produced highest yield from one plot (39.87). Significantly minimum production of spikes was observed 5 kR treatment and in cv. Eurovision. 6 kR and 7 kR treatments reduced production of spike drastically in cv. American Beauty while plants remain blind in other two varieties. Similar results were obtained by Raghava *et al.* (12) in cvs. Little Giant, Mansoer and wild Rose which did not flowered at 10 kR and 15 kR doses of gamma rays. The production of spikes was enhanced which might be due to slight increase in photosynthetic activities that encouraged by irradiations. There was no or less flower observed at higher doses

because of changes in plant metabolic activities and negative response of plant hormones to irradiations (Misra *et al.* (9)). Some floral abnormalities like increase in number of floral parts and size of florets was noticed in all varieties at lower doses. Petal size was also found different to its other counterpart in cv. Eurovision at 5 kR while aestivation of petals and florets was highly disturbed and floral fasciation was very conspicuous in higher doses in cvs. American Beauty and Novalux. Most of petals were broken and very light in colour than the original cultivar was also noted in 4 kR to 6 kR treatments. Such changes may occur due to physiological disturbances as has been reported by Banerji and Datta (1) that may be because of reshuffling of histogen layers. Some of the irradiation responses may be due to point mutations or to chromosomal aberrations, as in most of the cases, the abnormality in plants reverts back to normal growth during a recovery period suggests the basic cause to be non genetic physiological disturbances.

All treatments of gamma radiations had both positive and negative effect on multiplication and weight of corms and cormels. The mean number of corms and cormels per plant was adversely affected by gamma radiations at higher level but proved beneficial at 1 kR to 3 kR treatments over controls in vM₁ generations. Significantly maximum number of corms and cormels was produced by plants whose corms were treated with 2 kR dose (3.12 and 30.32) while 7 kR treatment of gamma rays recorded extreme reduction in number of corms and cormels. Significantly maximum mean number of corms was produced by cv. American Beauty *i.e.* 3.21 where as maximum number of cormels was produced by cv. Eurovision (27.72). Enhanced effect was observed in weight of corms at 1 kR to 3 kR then the control in vM₁ generation. The significantly maximum mean weight of corms and cormels was noted at 2 kR treatment (65.23 g and 7.78 g) and followed by 1 kR treatment (61.59 g and 6.89 g). Among all varieties, Cv. American Beauty had increased weight of corms (80.63 g) that was significantly maximum then other two cultivars in vM₁ generation where as weight of cormels was noted maximum in cv. Eurovision (6.20 g). The data related to corm size clearly indicates that the size of corm was significantly increased at 2 kR treatment (5.35 cm) and found *at par* with 2 kR (5.26 cm) while significantly minimum size of corm was noted at 7 kR for both generations (3.62 cm). The mean size of corm was recorded maximum in cv. Nova Lux (6.27 cm) which was followed by cv. American Beauty (3.85 cm) while smallest corm of 3.79 cm was produced by cv. Eurovision. The differences in responses under

different treatments in different varieties may be attributed to their genetic make up. On one hand, at higher doses, the reduction in production of the corms and cormels could be because of the ill-effects of treatments, as it hampered root system (Dhaduk (2) and Misra (6)) and cessation of growth of the auxiliary buds present on the corm by the inactivation of enzymes and hormones. Dhaduk (2) reported higher multiplication rate with more weight of corms and cormels was enhanced at lower doses of 1 kR and 3 kR in different varieties of gladiolus. In similar way, Misra and Mahesh (8) recorded maximum number of corms at 1 kR treatments in cvs. *Gladiolus callianthus* var. *Murielae*, Christian Jane, Psittacinus Hybrid and Oscar.

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